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A Metric/Modular Replacement for the 1-1/9-Bushel Fiberboard Container

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A Metric/Modular Replacement for the 1-1/9-Bushel Fiberboard Container

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Summary

The authors recommend an acceptable replacement for the 1-1/9-bushel (bu) container, the box most commonly used by the Florida fresh vegetable industry, from a group of five metric/modular-sized containers that occupy 100 percent of the surface area of the standard 48- by 40-inch (in) pallet. The 1-1/9-bu containers were compared for six commodities—bell peppers, cucumbers, acorn squash, greens (romaine), eggplant, and butternut squash. The five modularized containers, for comparison purposes, have outside dimensions as follows: (a) 400 by 300 millimeters (mm) (15-3/4 by 11-3/4 in), (b) 500 by 300 mm (19-3/4 by 11-3/4 in), (c) 500 by 400 mm (19-3/4 by 15-3/4 in), (d) 600 by 400 mm (23-1/2 by 15-3/4 in), and (e) 600 by 500 mm (23-1/2 by 19-3/4 in). All of these containers have depths of 300 mm (11-3/4 in).

The test containers were individually compared to the 1-1/9-bu container for the six commodities for average count, average shipping weight, and bulge. In every case the result was the same: the 500 by 300 by 300 mm container was the acceptable replacement for the 1-1/9-bu container. In each case the test container provided very similar payloads and offered similar handling characteristics, plus having the unitizing advantages of modular sizing.

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The produce shipping industry is using an excessive variety and number of container sizes and types. One estimate has identified 547 different sizes and types of containers[2] used for shipping 49 fresh fruit and vegetable items. This wide variety of container types and sizes contributes to the rising costs for packaging, handling, and transporting faced by shippers, receivers, and consumers of fresh fruits and vegetables.

The realization of this problem is not new. More than 30 years ago, L. C. Carey, in a report on "Containers in Common Use for Fresh Fruits and Vegetables," discussed this problem when he wrote, "Standardization or simplification has been defined as reduction in industrial waste through the elimination of unnecessary sizes, types, and dimensions of manufactured products. Consequently, as a consumer, the average citizen pays a large part of the ultimate aggregate increased costs of marketing fresh fruits and vegetables that are attributable to avoidable waste—waste due to the greater expense of manufacturing a large number of different sizes and types of containers; waste inherent in the handling of odd-sized containers in transportation and in storage; and waste due to damage in transit and in the distributive process . . . "[3]

Figure 1.—The 1-1/9-bu shipping container used extensively by the Florida produce shipping industry.

The excessive variety of containers can and should be reduced. Because the grocery industry has officially adopted, and the produce industry has endorsed, the 48- by 40-in pallet as a standard, this is a starting point. The popularity of this base dimension is growing now that interior widths of refrigerated trailer vans are increasing and allow "pinwheel" loading of palletized units that provide volume densities comparable to floor loads. Any standardized containers' sizes should be modular to the surface area of a standard pallet, so that the full advantages of unitization can be offered by use of standardized modular container sizes.

Considering the increased emphasis on agricultural exports and their importance in creating a favorable balance of payments, this standardization and modularization should be linked to the United States' move toward metrication. In 1961, the International Standards Organization (ISO) published ISO/R 198, "Double Deck Flat Pallets for Thru Transit of Goods," which recommended an international standard-sized pallet of 1200 by 1000 mm (47.3 by 39.4 in), which is very similar to the 48- by 40-in grocery pallet. Any container sizes designed to fit the 1200- by 1000-mm international pallet would also comfortably fit the 48- by 40-in domestic pallet.

This report discusses a modular-sized container that could be an acceptable replacement for the 1-1/9-bu container (fig. 1), which is used extensively by Florida's produce industry. The container has outside dimensions of 460 by 315 by 305 mm (18-1/8 by 12-1/2 by 12 in) and is the main package used to ship cucumbers, bell peppers, squash (including acorn, yellow, zucchini, and butternut), greens (including romaine, kale, and collards), okra, and eggplant. Of the containers used by the Florida State Farmers' Market System (FSFMS) that exceeded 17.5 million units last year,[4] about 30 percent or 5-1/4 million of these units were 1-1/9-bu containers. The FSFMS figure accounts for about one-half of the 1-1/9-bu containers in Florida, so the total annual volume of these containers could exceed 10 million units.

[2]*Stokes, D. R. and G. W. Woodley. Standardization of Shipping Containers for Fresh Fruits and Vegetables. MRR-911. USDA, 1974.*

[3]*Carey, L. C. Containers in Common Use for Fresh Fruits and Vegetables. Farmers Bulletin 2013, USDA, Production and Marketing Admin.*

[4]*Florida State Farmers' Markets Annual Report, Florida Department of Agriculture and Consumer Services, 1980.*

The objective of this project is to identify an acceptable replacement for the 1-1/9-bu container from the five modular-sized containers that occupy 100 percent of the surface area of a standard pallet. These containers will use all of the available space within a palletized unit. This report deals only with the physical feasibility of finding a good replacement for the 1-1/9-bu container from the modular containers studied. It is a presumption of this project that one of these five container sizes will be an acceptable replacement for most of the containers now in use. To support this contention, the authors recommend a replacement. A detailed analysis of costs and physical damage of metrication/modularization will be the subject of extensive future research.

In determining the container sizes to be compared, we looked to recommendations of the United Fresh Fruit and Vegetable Association (UFFVA) and the Economic Commission for Europe (ECE)[5] and to our own computer analysis for researchable container sizes based on the use of the unitization base.

We narrowed the field to nine container sizes which use from 90 to 100 percent of the unitization base. Further consideration reduced the number to five, which use 100 percent of the unitization base, because they offer unitized payloads that are more comparable to floor-loaded payloads. The nominal outside dimensions[6] of these containers are:

1. Container A—400 by 300 by 300 mm (15-3/4 by 11-3/4 by 11-3/4 in)
2. Container B—500 by 300 by 300 mm (19-3/4 by 11-3/4 by 11-3/4 in)
3. Container C—500 by 400 by 300 mm (19-3/4 by 15-3/4 by 11-3/4 in)
4. Container D—600 by 400 by 300 mm (23-1/2 by 15-3/4 by 11-3/4 in)
5. Container E—600 by 500 by 300 mm (23-1/2 by 19-3/4 by 11-3/4 in)

The 1-1/9-bu container uses only 84.5 percent of the international pallet base (1200 by 1000 mm) and 84.3 percent of the domestic pallet base. The replacement of this container with a more efficient modular size would offer savings through increased payload for unitized loads.

To compare the capacities of these five metric/modular container sizes with the 1-1/9-bu containers, we packed the commodities into each of the modular containers. We measured average weight, average count, and bulge for each standard-sized container. We compared dimensions and capacities of the modular and conventional containers to demonstrate the similarity and possible interchangeability that exists between the containers.

We compared the packing tests and actual packing conditions and determined a modular-sized container replacement for each individual commodity. The fiberboard containers used for these tests were full telescoping, single wall, and had tops with 200-lb test and bottoms with 275-lb test[7].

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[5]*Resolution 222—Recommendation on the Standardization of Packaging For The Transport of Fresh or Refrigerated Fruits and Vegetables.*

[6]*These outside dimensions include bulge.*

[7]*Bursting test value of 200 and 275 pounds per square inch.*

Cucumbers, green peppers, squash (acorn and butternut), greens, and eggplant were used in the packing tests. These commodities represent about 95 percent of all products packaged and shipped in the 1-1/9-bu container (fig. 2).

Figure 2—The 1-1/9-bu shipping container and most of the commodities tested in the project.

For comparative purposes, the results are presented separately for each of the six vegetables.

Bell peppers. The peppers were graded as "large" and varied from 4 in (height) by 3-3/4 in (diameter) to 3 by 3 in. The standard containers held an average of 75 peppers and weighed an average of 30.7 lbs. All the containers were bulk-filled and the peppers not placed in the containers in a predetermined packing pattern. The standard containers had no bulges.

The results of the tests are presented in table 1. The 500- by 300- by 300-mm container (fig. 3) held an average count of 75 peppers, the same amount held by the standard containers, and weighed an average of 30.8 lbs, almost the same weight as the standard container. The other test containers ranged from 62 to 156 peppers in their average counts and from 26.8 to 57.2 lbs in average shipping weights. Only containers A and B displayed no bulging. Because they are jumble-packed, the box depths were acceptable for all of the test containers. Container B, the 500-by 300-by 300-mm container, would be the most likely replacement for the 1-1/9-bu container because of their similar payloads, lack of bulging, and box depth.

Table 1.—Comparison of bell peppers packed in 1-1/9-bu containers and in five metric/modular-sized containers[1]

Container	Outside dimensions (l x w x h) (Mm)	Average count	Average shipping weight (Lbs)	Bulge[2]	Box depth	Acceptable replacement[3]
A	400 x 300 x 300	62	26.8	None	Good	—
B	500 x 300 x 300	75	30.8	None	Good	Yes
C	500 x 400 x 300	102	38.4	Slight	Good	—
D	600 x 400 x 300	131	48.1	Serious	Good	—
E	600 x 500 x 300	156	57.2	Serious	Good	—
Standard	460 x 315 x 305	75	30.7	None	Good	N.A.

N.A. = Not applicable.
[1]These peppers were jumble-packed in all containers.
[2]Rated as none for no bulge, slight for combined bulge to 1 in on both sides, moderate for combined bulge from 1 to 2 in on both sides, and serious for combined bulge in excess of 2 in on both sides.
[3]Only one of containers A through E can be rated as a replacement for the standard container.

Figure 3.—Bell peppers packed in one of the test containers.

Figure 4.—Cucumbers packed in one of the test containers.

Cucumbers. The cucumbers were graded as "super select" and ranged in length from 6-1/2 to 9-1/2 in, with an average of about 8-1/4 in. The standard containers examined held an average of 85 cucumbers and averaged 52.6 lbs. The cucumbers were packed in an end-to-end pattern along the length of the container. This pattern had to be place-packed by hand or machine and could not have been loaded this way by bulk filling because of the physical shape of a cucumber. The standard containers had no bulging.

The results of the tests are presented in table 2. Container B, the 500- by 300- by 300-mm container (fig. 4), which was the closest to the standard, held an average of 91 cucumbers and averaged 56.7 lbs. This container had no bulging and provided adequate packing and packaging for the product. The other containers ranged from 69 to 159 lbs in their average shipping weights. Only containers A, B, and C displayed no bulging. The 300-mm box depth, only 5 mm less than the standard container, was adequate for all of the containers tested with this product. Container B would be the most likely replacement for the 1-1/9-bu container for shipping cucumbers because of their very similar payloads and product-handling characteristics.

Table 2.—Comparison of cucumbers packed in 1-1/9-bu containers and in five metric/modular-sized containers[1]

Container	Outside dimensions (l x w x h) (Mm)	Average count	Average shipping weight (Lbs)	Bulge[2]	Box depth	Acceptable replacement[3]
A	400 x 300 x 300	69	43.1	None	Good	—
B	500 x 300 x 300	91	56.7	None	Good	Yes
C	500 x 400 x 300	119	78.1	None	Good	—
D	600 x 400 x 300	138	91.7	Slight	Good	—
E	600 x 500 x 300	159	101.6	Moderate	Good	—
Standard	460 x 315 x 305	85	52.6	None	Good	N.A.

N.A. = Not applicable.
[1]Cucumbers were packed in an end-to-end pattern in all containers.
[2]Refer to table 1, footnote 2.
[3]Refer to table 1, footnote 3.

Acorn squash. The squash varied in size from 3-1/4 by 3-1/8 in to 4-3/4 by 4-1/4 in. The standard containers held an average of 36 squash and averaged 45.2 lbs. These containers were jumble-packed. The standard container displayed no apparent bulging and the product was in good condition at destination.

The results of the tests with acorn squash are presented in table 3. Container B, the 500- by 300- by 300-mm container, held an average of 33 squash and averaged 43.6 lbs. This container when packed with this product displayed no bulging. The other test containers ranged from 26 to 73 in their average product counts and from 40.4 to 84.3 lbs in their average shipping weights. Containers A and B displayed no bulging and the others varied from slight bulging for container C to much bulging for container E. All of the test containers seemed to provide an adequate pack for the product. The 5-mm difference in depth between the standard and metric containers had no measurable effect on the condition of the product. Container B would be an acceptable replacement for the 1-1/9-bu container for shipping acorn squash because of their very similar characteristics of shipping, handling, and packaging, and also for shipping any other squash that has similar shape and physical characteristics.

Greens. In this case the greens were romaine, the most popular greens to be shipped in the 1-1/9-bu container. Both kale and collards also are shipped in it and would have packing and packaging requirements similar to romaine.

The standard containers held an average of 17 heads and averaged 19.8 lbs. Because of the more delicate nature and the greater variability in head sizes of this product, the individual containers had to be place-packed by hand to insure good condition of the greens and fully utilize the container. The standard container displayed no bulging and provided adequate packaging for the product.

The results of the tests with romaine are presented in table 4. Container B, the 500- by 300- by 300-mm container, held an average count of 18 heads of romaine and averaged 21.5 lbs. None of the test containers bulged and all provided adequate packaging for the greens. The lack of density of this product was the main contributing factor to these results. The other test containers varied from 15 to 51 heads in average product counts and from 16.9 to 51.1 lbs in average shipping weights. Container B would be an acceptable replacement for the 1-1/9-bu container for shipping greens such as romaine.

Table 3.—Comparison of acorn squash packed in 1-1/9-bu containers and in five metric/modular-sized containers[1]

Container	Outside dimensions (l x w x h) (Mm)	Average count	Average shipping weight (Lbs)	Bulge[2]	Box depth	Acceptable replacement[3]
A	400 x 300 x 300	26	40.4	None	Good	—
B	500 x 300 x 300	33	43.6	None	Good	Yes
C	500 x 400 x 300	47	58.7	Slight	Good	—
D	600 x 400 x 300	63	73.1	Moderate	Good	—
E	600 x 500 x 300	73	84.3	Serious	Good	—
Standard	460 x 315 x 305	36	45.2	None	Good	N.A.

N.A. = Not applicable.
[1]Acorn squash were jumble-packed in all containers.
[2]Refer to table 1, footnote 2.
[3]Refer to table 1, footnote 3.

Table 4.—Comparison of greens (romaine) packed in 1-1/9-bu containers and in five metric/modular-sized containers[1]

Container	Outside dimensions (l x w x h) (Mm)	Average count	Average shipping weight (Lbs)	Bulge[2]	Box depth	Acceptable replacement[3]
A	400 x 300 x 300	15	16.9	None	Good	—
B	500 x 300 x 300	18	21.5	None	Good	Yes
C	500 x 400 x 300	30	31.4	None	Good	—
D	600 x 400 x 300	36	36.3	None	Good	—
E	600 x 500 x 300	51	51.1	None	Good	—
Standard	460 x 315 x 305	17	19.8	None	Good	N.A.

N.A. = Not applicable.
[1]Romaine was place-packed in all containers.
[2]Refer to table 1, footnote 2.
[3]Refer to table 1, footnote 3.

Eggplant. The eggplants, typical of most Florida eggplants, had no size or grade, and varied considerably in size. The standard containers examined held an average of 19 eggplants and averaged 24.6 lbs. All of the eggplants were packed by hand with the butt end of the product facing out and the stem ends facing in along the length of the container. The standard containers displayed no bulging.

The results of the tests are presented in table 5. Test container B, 500 by 300 by 300 mm (fig. 5), held an average count of 21 eggplants and averaged 26.5 lbs. The other test containers ranged from 16 to 42 eggplants in their average counts and from 21.8 to 52.7 lbs in average shipping weights. Test containers A, B, and C displayed no bulging. Because the eggplants were packed butt out toward the sides of the containers and handpacked, the box depths were acceptable for all of the test containers. Container B, the 500- by 300- by 300-mm container, would be an acceptable replacement for the 1-1/9-bu container because of their very similar physical handling and capacity characteristics.

Table 5.—Comparison of eggplant packed in 1-1/9-bu containers and in five metric/modular-sized containers[1]

Container	Outside dimensions (l x w x h) (Mm)	Average count	Average shipping weight (Lbs)	Bulge[2]	Box depth	Acceptable replacement[3]
A	400 x 300 x 300	16	21.8	None	Good	—
B	500 x 300 x 300	21	26.5	None	Good	Yes
C	500 x 400 x 300	25	31.2	None	Good	—
D	600 x 400 x 300	38	42.3	Slight	Good	—
E	600 x 500 x 300	42	52.7	Moderate	Good	—
Standard	460 x 315 x 305	19	24.6	None	Good	N.A.

N.A. = Not applicable.
[1]Eggplants were packed with the butts out toward the sides of the container in all containers.
[2]Refer to table 1, footnote 2.
[3]Refer to table 1, footnote 3.

Figure 5.—Eggplant packed in a test container, and in the standard 1-1/9-bu container.

Butternut squash. The squash varied in size from about 6 to 14 in in length. The standard containers held an average of 23 squash and averaged 42.6 lbs. These containers were handpacked in a random pattern, depending upon the size and shape of each individual squash. The standard container displayed no apparent bulging and the product was in good condition.

The results of the tests are presented in table 6. Container B, the 500- by 300- by 300-mm container, was again the closest to the standard as it held an average of 24 squash and averaged 44.2 lbs. The other test containers ranged from 19 to 48 squash in their average product counts and from 36.6 to 86.0 lbs in average estimated shipping weights. Containers A and B displayed no apparent bulging as the others varied from moderate bulging for container C to serious bulging for containers D and E. The negligible difference in height between the test containers and the standard containers had no effect on the product. Container B would be the most likely replacement for the 1-1/9-bu container for shipping butternut squash because of their very similar shipping and handling characteristics.

Table 6.—Comparison of butternut squash packed in 1-1/9-bu containers and in five metric/modular-sized containers[1]

Container	Outside dimensions (l x w x h) (Mm)	Average count	Average shipping weight (Lbs)	Bulge[2]	Box depth	Acceptable replacement[3]
A	400 x 300 x 300	19	36.6	None	Good	—
B	500 x 300 x 300	24	44.2	None	Good	Yes
C	500 x 400 x 300	33	61.9	Moderate	Good	—
D	600 x 400 x 300	41	74.5	Serious	Good	—
E	600 x 500 x 300	48	86.0	Serious	Good	—
Standard	460 x 315 x 305	23	42.6	None	Good	N.A.

N.A. = Not applicable.
[1]Squash were random-packed in all containers.
[2]Refer to table 1, footnote 2.
[3]Refer to table 1, footnote 3.

During the research, six products usually shipped in 1-1/9-bu containers, representing more than 95 percent of all the 1-1/9-bu containers of produce shipped out of Florida, were packed into five metric/modular-sized containers. The containers fully utilize the available space in a unit on a standard-sized base of 1200 by 1000 mm. They were compared to each other and to the standard container for average count, average estimated shipping weight, bulge, pack, depth, and pattern. In every comparison the result was the same—the 500- by 300- by 300-mm container was the acceptable replacement for the standard 1-1/9-bu container.

The 500- by 300- by 300-mm container displaces 45,000 cubic centimeters or 2,746 cubic inches and the 1-1/9-bu container, which measures 460 by 315 by 305 mm, displaces 44,194 cubic centimeters or 2,697 cubic inches. This means that the most likely replacement displaces 1.8 percent more than the standard container. This increased volume would be expressed in approximately the same increased amount of materials required to construct the 500- by 300- by 300-mm container. This container enables greater utilization of the handling unit (i.e. pallet or slipsheet), which will yield a larger unitized payload per vehicle and fewer handlings and slightly greater average payload per container of approximately 2.3 percent (from this research). These factors should offset the slightly higher price of the slightly larger replacement container.

This process of selecting a replacement for currently used container sizes for fresh produce should yield about the same results for any container compared to these five metric/modular-sized containers. The 500 by 300 by 300 mm would not necessarily be an acceptable replacement for every container, but one of the five could, with some variability in the height, be an acceptable replacement that would have similar packing and shipping characteristics and similar payloads, and would require minimal system disruption, if adopted. The final result could be that the fresh fruit and vegetable industry will use only five different standard-sized containers. Much more research is needed to make this potential a possibility.

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